School Mathematics in Ghana: 1960 - 2000

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Abstract

The official school mathematics curriculum - textbooks, teacher's handbooks, and syllabus - has a powerful influence on classroom practice in a developing country like Ghana, where many teachers with low teaching qualifications hardly ever have access to other sources of information and activity for their teaching. The current official mathematics curricula materials for Ghanaian basic schools (the Ghana Mathematics Series) were originally written with the small intellectual elite, who will proceed to secondary and further education, in mind. This presentation examines

- why concerns were raised internationally for countries still using the 'new math' textbook schemes to adjust them;
- the effects of curriculum development projects in the mathematics and educational reforms on the Ghanaian school mathematics curriculum;
- how the Ghanaian official school mathematics curriculum is being reviewed to meet the challenges of the new millennium.

Introduction

Mathematics is one of the important subjects within the list of foundation subjects that constitute the core curriculum for basic (i.e. primary and secondary) education in countries throughout the world. The subject occupies a privileged position in the school curriculum because the ability to cope with more of it improves ones chances of social advancement (Mereku, 1992). It attained this position since it was made to replace classical languages like Latin or Greek which prior to the early half of this century were used as screening devices for entry to higher education and certain professions. As advances in computer technology have increased the usefulness of the subject and will continue to do so in the new millennium, there is the need to understand how these advances have revolutionised the content of, and emphasis in, school mathematics.

Currently, the mathematics syllabus for basic schools is under review to reflect the changing views about the subject and what is valued globally in it. In this paper, a historical background to the development of mathematics curriculum materials in Ghana is presented. The presentation is to enable mathematicians and teachers of mathematics to understand and appreciate the mathematical content and processes emphasised by the 'new' basic mathematics syllabus which will be used in our basic schools in the new millennium.

Developments in School Mathematics

The Canonical Mathematics Curriculum

The view that 'mathematics is a language, and provides a means of communicating information because it makes use of symbolic notation which is similar across continents, abstract ideas and concepts' has made many people to see the subject as universal. It was therefore very common in history to see countries using texts and syllabuses developed in other countries that were more developed, at least, in terms of mathematics. In tracing

this history, Howson (1978: 133) briefly recounted that

> In medieval times the teaching of mathematics in England depended very much on written works of the Roman Boethius and the Greek Euclid. Later England and France exported text, such as Dilworth's Arithemetic and Legendre's Geometry to the developing United States of America. In the early parts of this century, the school children of the Empire (now Commonwealth) learned their mathematics from Hall and Knight, Godfrey and Siddon and later Durell.

It is not surprising that Ghana, the first African country to break away from the British Empire has preserved several of its educational traditions and for a long time, continued to use, in mathematics, curricula which were very similar to those developed for pupils in Europe and America.

At an International Mathematics Seminar in Kuwait in 1986, it was pointed out that

> the 'Western' curriculum, which was designed in a particular historical and cultural context for a few, has not only been forced upon all in recent years but also exported to other countries across the world (Howson and Wilson, 1986:8).

An international mathematics study in twenty developing and developed countries indicated that topics taught at the lower secondary level or to students between the ages of 12 and 15 years are similar to those taught at the same level in England (Travers and Westbury, 1989). In a similar analysis, Mereku (1990) found that the mathematics topics taught in the lower secondary level in three West African countries - Ghana, Nigeria and Sierra Leone - were similar to those taught at the same level in England. These are indications that curricula designed in a particular historical and cultural context were imported and not properly adapted. These observations support the fact that the school mathematics curriculum inadvertently acquired a universal status which unfortunately led many countries across the world to view it as canonical.

New Math

The changes in curriculum that resulted in re-naming the subject 'new-math' in America and 'modern mathematics' on the our side of the Atlantic, came as a result of a campaign for changes in the content of school mathematics. These changes were to allow the use of an approach to mathematics that will enable children to learn basic language and structure of mathematics as soon as possible. The major aim of new math was to link school mathematics with university (or higher) mathematics. The emergence of modern mathematics saw significant changes in the selection and the mathematical treatment of content at all levels of pre - university education in Ghana in the late 1960s and the early 1970s.

According to Howson, Keitel, and Kilpatrick, (1981), the need to bring the content of school mathematics more in line with university mathematics became necessary because the century preceding World War II saw the discovery of more mathematics than ever existed in the history of man. Several new results were reached in mathematics and announced. New methods and techniques for solving both old and new problems were developed and new concepts were created.

As early as 1967 the West African Examination Council had begun to set school certificate examinations on the work of the new math. And by 1971 the Primary School Mathematics Syllabus had been revised and completely transformed into a modern mathematics syllabus and was ready to be sent out to all schools (Ghana Ministry of Education, 1972, p. 69). Traditional arithmetic was taught in the primary school side by side with such new topics as logic and sets, measurement, shape and space and statistics and probability. Though we no longer talk about 'modern' or 'traditional' but just mathematics, sets run through all school mathematics. Number is seen as a property of a set, and teachers are strongly advised that the language, concept, pictorial representations and practical experiences of sets should be their starting points and should run through the mathematics they teach.

Mathematics Textbooks Development Projects

The new math led to major curriculum projects across continents between the 1950s and 1970s. This period saw many African countries obtaining their independence. The desire to improve education to meet the developmental needs of the new nations therefore created the ready desire for change before the new

math curriculum innovations reached the continent (Hawes, 1979). This desire led to the emergence of curriculum development committees or projects and the organisation of several conferences. Two main curriculum projects were involved in carrying out the new math innovation in Ghana. The first, which was inaugurated in Africa as early as 1961, was the African Mathematics Programme (AMP). The second was the Joint Schools Project (JSP).

African Mathematics Programme (AMP).

The AMP spearheaded the major curriculum changes in Africa. The AMP pursued a policy of bringing together African, American and British educators in English speaking African countries to influence mathematics education in Africa. To achieve its objectives, it organised writing workshops in Africa which produced several mathematics textbook schemes (Lockard, 1968). As a result the AMP developed the Entebbe Math Series (Commonwealth Secretariat, 1969, p. 156). These included materials for modern mathematics texts for primary, secondary and teacher training. Personnel were trained in editing and evaluation. The AMP schemes were tested in a small number of experimental schools mainly in the urban areas of the participating African countries. But the full implementation of the schemes was delayed for over a decade.

In the 1970s, two regional programmes were established to modify the AMP mathematics schemes for all institutions in the countries participating in the programme (William, 1976). One was the West African Regional Mathematics Programme (WARMP), which adapted the AMP mathematics schemes for primary, secondary, and teacher training, to the requirements of three participating countries: Ghana, Liberia and Sierra Leone. The other was the East African Regional Mathematics Programme (EARMP), which adapted the AMP mathematics schemes for the participating countries in East Africa.

The mathematics schemes currently being used in Ghana, the *Ghana Mathematics Series* (GMS) textbooks and Teacher's Handbooks (CRDD, 1986a, 1986b), were products of the WARMP. The series for primary schools were first published between 1975 and 1977 by the Ghana Ministry of Education. Those for junior secondary schools could not be published until 1988 when funding was obtained as a result of the Educational Reform Programme.

The Joint Schools Project (JSP).

Around the same period as the GMS schemes were being written, an initiative had began to design new schemes for secondary schools. This was the Joint Schools Project (JSP). The project was originated by Dr. E. M. Hartley (University of Ghana), Miss M. W. L. Harbourn and Mr. B. Raynor (both of Achimota School), and Mr M. C. Mitchelmore (Mfantsipim School). The project was aimed at "producing *new mathematics* course for secondary schools in West Africa, up to school certificate level" (Lockard, 1968). It was funded by three UK agencies - The Nuffield foundation, London; the Centre for Educational Development Overseas, London; and Overseas Development Administration, London. Associated agencies which also provided support for the project include the Mathematical Association of Ghana (MAG); University of Ghana; and the Ghana Ministry of Education.

The Joint Schools Project (JSP) team began the project working as a sub-committee of the MAG, and became self-directing in April 1965 with the appointment of an Executive Committee. In June 1971, when the majority of the experimental work has been completed, the Executive Committee was dissolved. The responsibility for completing and reviewing the JSP books became that of the editors and MAG. This has been done thrice since the books were first published in 1970.

The third review in collaboration with SEDCO Publishers to meet the mathematical needs of the changed structure of secondary education is yet to be completed. This last review was to abridge the 5-year series to a 3-year series for the senior secondary system. Book 1 is already on sale in bookshops all over the country and the publishers expect to get the other two books (i.e. books 2 and 3) ready before the 1999/2000 academic year begins in September.

The project originally produced textbooks in mathematics for Secondary Schools Forms 1 - 5, or age 11- 18. It was designed to meet the needs *of "all ability levels commonly found in secondary schools (approximately, top 15% of ability range)"* (Lockard, *op cit*).

The curriculum projects largely affected the development of school curriculum also in Ghana.

Differences between the JSP and AMP Curriculum Materials

It is necessary to point out here that even though the two curriculum projects were involved in development of mathematics materials, the products of African Mathematics Project which was largely American initiative differed in several ways from those of the Joint School Project which was British initiative. In the former the content and treatment of topics in primary mathematics was changed completely. Below is how Perreley (1988), an expert in mathematics education, described the changes.

> "In the primary schools set theory and the operations on sets were considered before the natural number itself. The mathematical operations were built on corresponding operations between sets. Geometry appeared from the beginning based first on the concept of topological transformation, and later as a projective and metric transformation. The algebraic structures became the framework for both arithmetic and geometry.
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> In the secondary school, the same subjects were developed with greater rigour. In particular, by introducing the vectorial plane, the whole geometric structure was rebuilt, even using algebraic terminology. In a parallel way, there were early introductions to probability and to statistics, subjects completely new to pre-university education, and even to the university curriculum for future teachers of mathematics" (Perreley, 1988:872).

The changes that came with the JSP schemes were not so marked as those described above. The work of the JSP team was targeted mainly for secondary level mathematics, and did not presume the content would change so much at the primary level. Hence the change in content and approach to mathematics was not as drastic as what we saw in the AMP projects.

We therefore had a situation where the major mathematics schemes used in our basic and secondary schools lacked continuity since they came from two different projects. That is, the Ghana Mathematics Series (GMS) for basic schools and the Joint School Project (JSP) books for secondary schools were not compatible. The two projects were developed on different philosophies, their contents and style of presentation completely different. It was therefore not a surprise that most Ghanaian students experienced difficulty in switching to the JSP at the secondary level after using the GMS schemes in basic schools.

The Changed Structure of Education in Ghana

As a result of the reforms in education which began in 1987, the '6-3-3' structure of pre-university education has replaced the '6-4-5-2' structure, and thus, reducing the age at which the majority of students write their matriculation (i.e. university qualifying) examination from 23 years to 18 years. The first part of secondary education [i.e. junior secondary school (JSS)] is now comprehensive. That is, education at JSS level is now accessible to the majority, or as many children of school-going age as possible. The introduction of JSS resulted in the shortening of the period of pre-university education from a possible of 17 to 12 years.

Notwithstanding the changes in the educational structure, the scope as well as complexity of the content of the curricula for both senior and junior secondary schools were raised over and above what existed in GCE O'level, and Middle School Leaving Certificate level, respectively. Besides, all pupils in secondary education (both JSS and SSS) are made to follow similar syllabuses in the heavily loaded curriculum. As it is now very clear, only a few of the students are really capable of understanding the content prescribed by these syllabuses.

Influence of the Educational Developments on School Mathematics

The above developments have contributed in several ways to the decline in student performance in the subject. The development of the canonical school curriculum for mathematics inhibits any

form of curriculum development that will be planned in the subject in a developing country, especially in Ghana, where the curriculum is meant for a mass educational system. Thus teaching to all the mathematics which is aimed at the preparation of those who would go to study further mathematics at the university is inimical to the realisation of the national goals of education. To the majority of pupils, the canonical mathematics syllabus can offer very little opportunity to learn the basic mathematics concepts and skills that will be required to understand the environment, function properly in it and contribute positively to its development.

In the current basic school mathematics syllabus, there is still the presence of topics which emphasise the structural and deductive aspects of mathematics (i. e. sets-theoretical approach; algebraic expressions; axiomatic approaches). These indicate that Ghana has not yet joined the retreat from positions taken up in the 1960s in curriculum development in the subject. The school mathematics curriculum is still 'modern' (or new) math, that is, it emphasises the preparation of students who will do mathematics in further education or university.

At the JSS level, the mathematics syllabus is compartmentalised into Years I, II and III. Its design however, does not follow the spiral method, that is, the sequence of topics is not the same every year. Most topics which involve actual operations on numbers, fractions and measures occur in Year I; and with the exception of ratio and proportion and some applications of percentages, the topics for Year II and Year III are those that require some level of abstraction. Most of these topics which found their way into school mathematics as a result of the new math are in fact not relevant to the needs of the majority of JSS pupils who will not do higher mathematics after Basic Education. Among these are topics like quadratic equations, simultaneous equations, and logarithms.

In the mathematics syllabus and textbooks, the 'new math topics' have been broken into more units, and the notes on them cover more pages than the notes on the basic arithmetic topics. Since this reinforces the view of many mathematics teachers who think the modern mathematics came to replace the 'old', they continue to devote more time to the treatment of topics such as sets, operations on sets, numeration systems, integers and rational numbers. Very little attention is given to those that involve basic number operations and real life applications. There is nothing on calculators even though the devices are now increasingly being used by people in commerce and industry.

Although the spread of modern mathematics was largely due to both the new approaches to learning developed by psychologists and new content areas introduced into mathematics, these approaches were not as easy to adopt as the additional content or topics. A curriculum analysis study conducted by Mereku (1995) revealed that though there was rhetoric in the introduction of the curriculum materials on the use of teaching skills that suggest discovery methods, the learning/teaching activities that would encourage the use of such teaching skills in the materials were not included. The teachers were themselves not aware of the underlying structures of the approaches. Therefore in the JSS, many teachers are very likely to find it difficult to cope with the teaching of some of the modern mathematics topics that occur in the syllabus for years II and III. So several of them are likely to skip some of the topics.

The influence of the above developments on the school mathematics curriculum has been tremendous. A study commissioned by the ministry of education in the early part of this decade revealed that achievement of public schools is low in spite of in-service courses organised for teachers to improve the teaching and learning processes in schools, and in spite of the injection of inputs into schools. The study also indicated that mathematics teaching in basic schools focuses on computation skills, learning of formulas, rote practice and teaching as telling. The principal investigator in this study, Kraft (1994) argued that

> "the current syllabi, textbooks and teachers' handbooks do not meet the highest international standards, nor the current best thinking on sequence, learning and pedagogy and will not

prepare Ghanaian students for the needs of the next century" (Kraft 1994: 2).

This has been the nature of school mathematics curriculum that students entering secondary education in Ghana have received. The implication here is that by the time the majority of pupils begin secondary education their foundation in basic school mathematics is woefully low.

Implications for School Mathematics in the New Millennium

The limitations discussed above point to the fact that the basic mathematics curriculum that has remained in our schools for nearly three decades has little to offer the majority of pupils, thus those who will not continue to learn mathematics after junior secondary. Although the pupils will have experienced the kind of mathematics that only few had access to in the traditional secondary system, most of them at the end of the JSS will not be numerate. They will have very little opportunity to learn the basic mathematical concepts and skills that will help them to understand their environment, functions properly in it and contribute towards its development.

To overcome the inefficiencies in the curriculum, the current syllabus review panel's work was influenced by certain principles. The final part of this presentation will therefore relate some of the principles that underpinned what has been included in the new JSS syllabus.

To meet students' mathematical needs in the next millennium requires that the syllabus is designed in such a way as will enable all pupils to have the opportunity to study a style of mathematics appropriate to them as individuals. The content should be such that it can be developed sufficiently so that they can be applied in ways which the students can understand. There is no value in devoting a substantial proportion of the syllabus to teaching topics involving formal set theory, algebraic structures, number systems, logarithms, to mention only a few, to all pupils. This is because not all of them have the knowledge to be able to appreciate the contexts within which the topics are of use.

The new math was an attempt to link school mathematics to university or further mathematics. But today, there is a shift in emphasis in the curriculum all over the world. School mathematics is now being linked with everyday life mathematics. The content has been re-organised to emphasise mathematical processes (i.e. what mathematicians really do). Some of these are mental computations, practical measurement, estimation, approximations, building numerical and spatial patterns, real life applications, problem solving, investigations, and the use of such technologies as calculators and computers. Finally, the syllabus emphasises teaching activities that will enable the full development of students' verbal and mental abilities in mathematics so as to ensure their quick recall of basic number facts.

References

CRDD - Curriculum Research and Development Division of GES, (1986a) *Ghana Mathematics Series: Primary Pupil's Book 1* –6 (2nd edition) Accra : Ghana Publishing Corporation.

CRDD - Curriculum Research and Development Division of GES, (1986b) *Ghana Mathematics Series: Teacher's Handbook 1* – 6 (2nd edition) Accra : Ghana Publishing Corporation.

Commonwealth Secretariat, (1969) Mathematics in the Commonwealth, London: Commonwealth Secretariat p. 156).

Ghana Ministry of Education, 1972, *Ghana Ministry of Education Report*, Accra: Ghana Publishing Corporation. p. 69.

Hawes, Hughes (1979) *Curriculum Reality in African Primary Schools*, Bristol, England: Longman.

Howson, G. (1978). 'The diffusion of New Ideas' In G.T. Wain (ed), *Mathematical Education*, Wokingham, England: van Nostrand Reinhold Company., p. 8).

Howson, A.G., Keitel, C. and Kilpatrick, J., (1981). *Curriculum Development in Mathematics*, Cambridge: Cambridge University Press.

Howson A. G. and Wilson B. (1986) *School Mathematics in the 1990s*, Cambridge: Cambridge University press.

Kraft, R. J. (1994) *Teaching and learning in Ghana: a curriculum, textbook, syllabus*

and handbook analysis. Accra, Ghana.: Ministry of Education.

Lockard, J. D. (1968) *Sixth report of the international clearing house on science and mathematics curricular developments- 1968*, The Universty of Maryland: Science Teaching Centre / Commission on Science Education for the American Association for the Advancement of Science.

Mereku, K D. (1990) '*The Mathematics Syllabus for Ghana Junior Secondary Schools and the National Educational Reform Programme'*, University of Leeds: School of Education. (M.Ed. coursework presentation, 35 pages).

Mereku, K D. (1992) 'School Mathematics The misplaced Emphasis', *The People's Daily Graphic,* September 19, 1992.

Mereku, K D. (1995) '*A comparison of the official primary mathematics curriculum in Ghana with the way in which it is implemented by teachers'*, University of Leeds: School of Education. (Ph.D. Dissertation, 374 pages).

Pellerey, M. (1988) 'Mathematics Instruction' In A. Lewy (ed). (1988) The *International Encyclopedia of Curriculum*, Oxford: Pergamon Press, p 870-881.

Travers, K. J. and Westbury, I (1989) The IEA study of mathematics 1: Analysis of mathematics curricula. Oxford Pergamon Press.